SOLID STATE FERMENTATION OF *Monascus purpureus* IN STIRRED DRUM BIOREACTOR FOR PRODUCTION OF RED PIGMENT FROM OIL PALM FROND

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Engineering (Bio-Process).

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Disebabkan terdapat pelbagai keprihatinan mengenai kesan pewarna sintetik, pengeluaran pewarna semulajadi secara besar-besaran menjadi alternatif yang berpotensi dalam memenuhi permintaan pewarna dalam industri makanan. Kajian ini memberi tumpuan kepada keupayaan dram bioreaktor untuk menghasilkan pewarna merah menggunakan *Monascus purpureus* FTC 5357 dan pelepah kelapa sawit (OPF) sebagai substrat, melalui proses fermentasi secara pejal. Terdapat tujuh parameter yang terlibat iaitu kandungan lembapan awal (% v/w), saiz inokulum (spora/mL), kepekatan peptone (% w/w), pH awal, kadar pengudaraan (vvm) program agitasi (kitaran/hari) dan kapasiti muatan (% v/v) telah diuji untuk menentukan kadar penghasilan pigmen merah, biomas dan penggunaaan glukosa. Tiga respon, iaitu pengeluaran pigmen merah, biomas, dan penggunaan glukosa, untuk mengenal pasti faktor-faktor penting yang mempengaruhi proses fermentasi secara pejal. Teknik satu faktor pada satu masa (OFAT) dan kajian saringan faktorial rekaan 2 peringkat telah digunakan dalam kajian ini. Dalam kajian OFAT, pengeluaran pigmen tertinggi ditunjukkan pada kadar pengudaraan 1 vvm (6.09 AU/g) dan pengeluaran terendah menunjukkan pada 45% kandungan lembapan awal (0.1 AU/g). Dalam dua peringkat reka bentuk faktorial, pengeluaran maksimum pigmen adalah 71.86 AU/g dengan menggabungkan 75% v/w kandungan lembapan awal, 10^8 spora/mL saiz inokulum, pH awal 4, kadar pengudaraan 1.21 vvm, kapasiti muatan 35% v/v dan program agitasi adalah 6 kitaran/hari. Faktor yang paling penting yang menyumbang kepada pengeluaran pigmen merah ialah kadar kelembapan awal, dengan nilai F dan nilai p pada 46.54 dan 0.0002, masing-masing diikuti dengan saiz inokulum, dengan nilai F dan nilai p ialah 14.12 dan 0.0071. Pemerhatian yang sama juga terdapat pada biomass, di mana kelembapan awal menjadi penyumbang tertinggi dengan nilai F dan p adalah 55.07 dan 0.0051, diikuti dengan kepekatan peptone dengan nilai F dan p adalah 20.47 dan 0.0202. Kesimpulannya, kajian ini telah membuktikan potensi penggunaan dram bioreaktor dan substrat OPF dalam pengeluaran pigmen merah yang lebih tinggi (71.86 AU/g) berbanding dengan penapaian secara di dalam tabung balang (2.3 AU/g).

ABSTRACT

Various concern have been reported regarding the effect of existing synthetic colorant, hence, mass production of natural colorant seems to be a potential alternative in fulfilling the demand of colorant in industries. This research has emphasized on the process capability of stirred drum bioreactor on performing solid state fermentation (SSF) of *Monascus purpureus* FTC 5357 by using oil palm frond (OPF) for production of red pigment. Seven parameters, namely, initial moisture content (% v/w), inoculum size (spores/mL), peptone concentration (% w/w), initial pH, aeration rate (vvm), loading capacity (% v/v) and agitation programme (cycles/day) were evaluated for red pigment production, biomass, and glucose consumption. One Factor at A Time (OFAT) and two level factorial screening designs were used in the study. Three responses, which were red pigment production, biomass, and glucose consumption have been used as responses to identify the significant factors affecting the SSF process. In OFAT studies, the highest pigment production was recorded at aeration rate of 1 vvm (6.09 AU/g) and the lowest production was obtained at 45% of initial moisture content (0.1 AU/g). In two level factorial design experimental studies, the highest pigment production was 71.86 AU/g by incorporating 75% v/w of initial moisture content, 10^8 spores/mL of inoculum size, initial pH of 4, aeration rate of 1.21 vvm, loading capacity of 35 % v/v and agitation programme of 6 cycles/day. The most significant factor contributing to the red pigment production was initial moisture content, with F-value and p-value of 46.54 and 0.0002, respectively, followed by inoculum size, with F-value of 14.12 and p-value of 0.0071, respectively. Similar observation also occurred for biomass, shows that highest contribution from initial moisture content with F-value of 55.07 and p-value of 0.0051, followed by peptone with F-value of 20.47 and p-value of 0.0202, respectively. In conclusion, this work demonstrated the potential of using stirred drum bioreactor and OPF substrate in producing higher yield of red pigment production (71.86 AU/g) compared to shake flask fermentation (2.3 AU/g).

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LIST OF ABBREVIATIONS

Abs	Absorbance
ANOVA	Analysis of variance
CCD	Central composite design
cm	Centimetre
df	Dilution factor
DM	Dry matter
DNS	Dinitrosalicyclic acid
EFB	Empty fruit bunch
g	Gram
hrs	Hour
L	Litre
Mm	Milimetre
MPOB	Malaysian Palm Oil Board
nm	Nanometre
OD	Optical density
OFAT	One factor at One Time
OPB	Oil palm biomass
OPF	Oil palm frond
OPK	Oil palm kernel
OPS	Oil palm shell
OPT	Oil palm trunk
SmF	Submerge fermentation
SSF	Solid state fermentation

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